ESTIMATING THE PROBABILITY OF ACHIEVING SHORTLEAF PINE REGENERATION AT VARIABLE SPECIFIED LEVELS

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POSTER SUMMARY

A model was developed that can be used to estimate
the probability of achieving regeneration at a variety of
specified stem density levels. The model was fitted to
shortleaf pine (*Pinus echinata* Mill.) regeneration data,
and can be used to estimate the probability of achieving
desired levels of regeneration between 300 and 700
stems per acre 9-10 years after thinning to a specified
level of overstory basal area per acre. The level of
regeneration to be achieved was used to modify a logistic
model to estimate probability of obtaining regeneration at
the desired level. Variables used in the model to predict
probability of achieving the desired regeneration level
were site index for shortleaf pine (base age 50), overstory
basal area, age at time of thinning and a dummy (0 or 1)
variable representing year of plot establishment.

The data consisted of measurements made on 5-milacre
plots located within 182 circular permanent plots, 0.2-
acre in size. These plots were established in natural
even-aged pure shortleaf pine stands thinned to predeter-
mined residual overstory basal area levels in one of four
density categories: 30, 60, 90 or 120 square feet per
acre. Plots were established in four age categories (20,
40, 60 and 80 years) and in four site index classes (50,
60, 70, 80 feet at 50 years). At the time of plot establish-
ment hardwoods were treated with herbicide by tree
injection or girdling. Each 0.2-acre plot was surrounded
by a 33-foot buffer strip, which received the same
thinning and herbicide treatment. Shortleaf pine
regeneration stems were tallied on two 5-milacre plots
located due north and south midway between the plot
center and the boundary of each 0.2-acre shortleaf pine
overstory plot. The regeneration sample occurred 9-10
years after plot establishment.

Larson and others (1997) used a logistic model to predict
the probability of achieving specified levels of oak
regeneration. Target density levels could not be varied
within a particular equation for the models developed by
Larson and others (1997). However, they fitted several
equations independently to different target density

levels. For the current study, varying levels of shortleaf pine
regeneration density levels were obtained by using the
natural logarithm of the specified density level as an
independent variable in a logistic model. To obtain a
satisfactory fit for the model it was necessary to form an
independent variable by multiplying the natural logarithm of
density level by the square of site index.

Parameter estimation for this model with common logistic
regression software is problematic because the level of
regeneration success is variable. Therefore, a maximum
likelihood procedure was developed and used to estimate
parameters in this model. Three levels of regeneration
success were specified for the purpose of parameter
estimation: 300, 500 and 700 stems per acre. These levels
were used to define regeneration categories such that
each plot could be assigned to one of these categories, for
example, more than 300 but less than 500 stems per acre.
A multinomial distribution based on these categories was
used to develop a likelihood function. The modified logistic
function was used to represent probabilities in the likeli-
hood function. The LOGDEN function in SHAZAM (White
1993) econometric software was used to maximize the
likelihood function with respect to equation parameters so
that maximum likelihood estimates were obtained.

Parameter estimates from the model indicate that ad-
equate shortleaf pine regeneration is less likely on good
sites than on poor sites as measured by shortleaf pine site
index. Adequate shortleaf pine regeneration becomes less
likely as overstory basal area per acre increases, and is
less likely at young overstory stand ages. The parameter
estimate associated with year of thinning and herbicide
treatment indicates that the probability of obtaining ad-
equate regeneration can vary substantially due to the year
in which thinning and herbicide treatment occurred. This
could be due to variability in shortleaf pine seed crops and/
or conditions for seedling establishment and survival. The
resulting model for prediction of probability for regeneration
success should be applicable for levels of shortleaf pine
regeneration between 300 and 700 stems per acre.

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REFERENCES

Larson, D.R.; Metzger, M.A.; Johnson, P.S. 1997. Oak regeneration and overstory density in the Missouri Ozarks. Canadian Journal of Forest Research. 27: 869-875.

White, K.J. 1993. SHAZAM user's reference manual version 7.0 - second printing. New York: McGraw-Hill. 482 p.